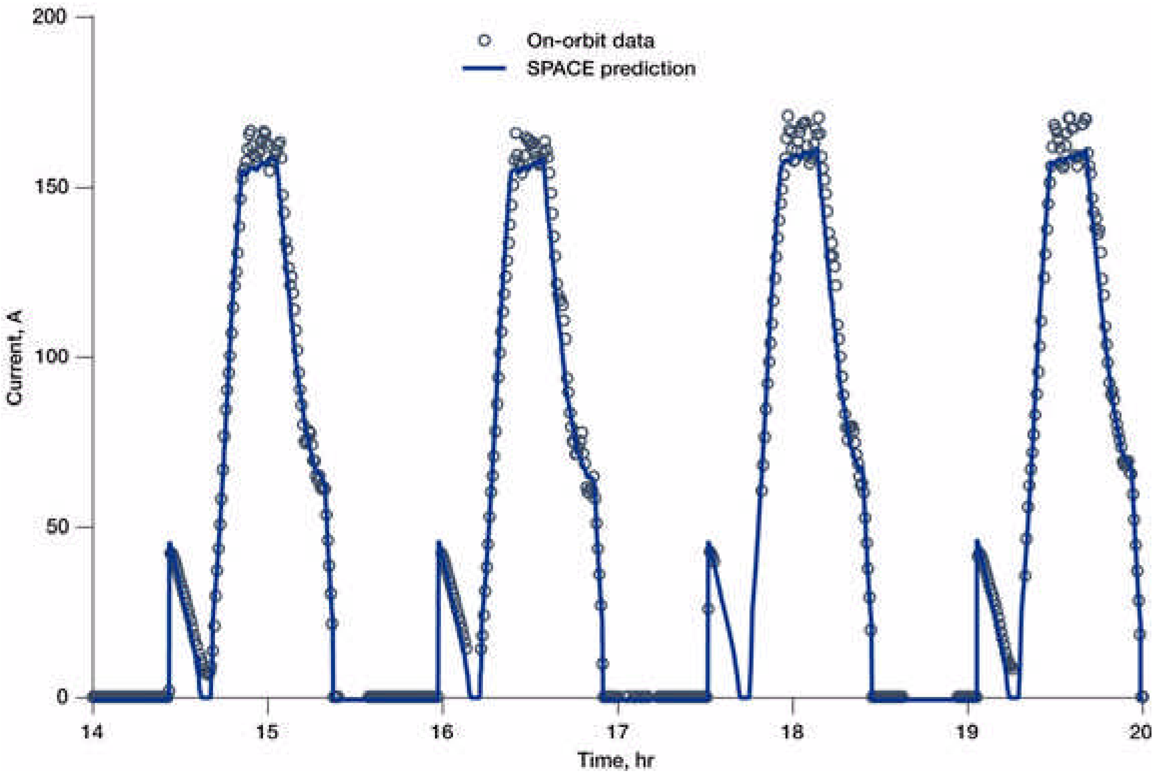
International Space Station Power System Model Validated

On-orbit view of the International Space Station taken from the space shuttle in March 2001.

System Power Analysis for Capability Evaluation (SPACE) is a computer model of the International Space Station's (ISS) Electric Power System (EPS) developed at the NASA Glenn Research Center. This uniquely integrated, detailed model can predict EPS capability, assess EPS performance during a given mission with a specified load demand, conduct what-if studies, and support on-orbit anomaly resolution.

The first U.S. power module was launched to the ISS on November 30, 2000. This module boasts two solar arrays, the largest ever flown in space, each capable of producing more than 30 kW of power. The module also contains batteries to power the ISS when it is in the Earth's shadow and the associated cables and power electronics to route power to electrical loads.

The model validation process reviewed a range of on-orbit data, compared them with SPACE input data, and output the results. Pertinent data in the downlinked data stream were determined, and several time periods with minimal data dropouts were identified. These data were gathered using tools available in Glenn's Engineering Support Room, which can be staffed by Glenn engineers to support ISS operation. SPACE input and output generated from running the SPACE code were compared with the on-orbit telemetry. The comparisons looked at all aspects of the power system, including solar array performance from both the front and back, array pointing uncertainty, battery performance, dc-to-dc converter efficiency, battery charge-discharge efficiency, and the overall ISS EPS system performance.



Comparison of on-orbit data with SPACE predictions for solar array output current. Long description Current varies from 0 A during eclipse to approximately 170 A during sunlight. The data points (on-orbit data) match the line (SPACE prediction) very well throughout the entire time period.

This plot compares SPACE predictions and actual ISS telemetry. It shows the usable current produced by one of the two solar arrays. During this four-orbit period, the solar arrays are in a fixed position so the current varies during the orbit. At the beginning of each sunlight period, the back of the array (which generates power less efficiently than the front) faces the Sun. As the sunlight period progresses, the Sun transitions from the back of the array to the front, and thus the current falls off, then steadily increases. During the second half of the sunlight period, the usable current decreases; once the batteries become fully charged, excess current is shunted away to prevent overcharging the batteries. The shaded areas in the plot indicate when the ISS passes through the Earth's shadow, and thus the solar arrays produce no power. The SPACE prediction matches the on-orbit data extremely well during all phases of the orbit. In fact, for the cases examined thus far, SPACE predictions of currents, voltages, and other parameters consistently match on-orbit performance within approximately 5 percent.

With this validation against the actual on-orbit performance of the ISS EPS this year, the development of SPACE has reached a significant milestone. SPACE predictions can be used with greater confidence than ever in planning future operations of the ISS.

Find out more about this research. http://space-power.grc.nasa.gov/ppo/

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